

1 combination or thermal pressing combination to combine two layers together,
2 herein material of the interfaces on the foil layer is changed from aluminum to
3 stable alumina (Al_2O_3), to achieve the foil packaging.

4 Since the combination strength of the foil packaging is excellent, it is
5 difficult to separate the foil layer containing aluminum from the plastic
6 membrane and the paper layer during recycling processes. Because the foil
7 packaging is widely used in modern life, predictably, considerable quantities of
8 waste foil packaging will be produced and cause environment problems and
9 extreme waste of usable resources if the materials of the foil packaging can not
10 be reused.

11 Because of the difficulty of separating the foil layer, most of the foil
12 packaging is treated as waste after use. One conventional separating and
13 recycling method for foil-laminated material is a physical treatment that
14 pulverizes the foil-laminated material into pieces to separate the foil layer from
15 the plastic membrane or paper layer by the tearing force. However, using this
16 conventional separating method not only has troublesome processes and high
17 operating cost, but also has low recycling purity and low recycling value of the
18 material. Furthermore, the separation is incomplete due to some foil layer
19 residue being on the plastic membrane (or the paper layer) or some plastic
20 membrane (or the paper layer) residue being left on the foil layer.

21 To overcome the shortcomings, the present invention tends to provide an
22 improved separating method for recycling foil-laminated material to mitigate
23 and/or obviate the aforementioned problems of the conventional separating
24 method for recycling useful materials from the foil-laminated material.

1 SUMMARY OF THE INVENTION

2 The main objective of the invention is to provide a separating method for
3 recycling foil-laminated material wherein a chemical treatment uses nitric acid
4 solution to permeate the plastic layer or the paper layer to dissolve the alumina
5 layer, whereby the foil layer, plastic layer, and the paper layer of the foil-
6 laminated material are completely separated for efficient recycling.

7 Other objects, advantages and novel features of the invention will
8 become more apparent from the following detailed description when taken in
9 conjunction with the accompanying drawings.

10 BRIEF DESCRIPTION OF THE DRAWINGS

11 Fig. 1 is a block diagram of a separating method for recycling foil-
12 laminated material in accordance with the present invention; and

13 Fig. 2 is a schematic equipment flowchart of the separating method for
14 recycling foil-laminated material in accordance with Fig.1.

15 DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

16 A separating method for recycling foil-laminated material in accordance
17 with the present invention comprises the following acts of: soaking waste foil-
18 laminated material in a stripping agent until different layers of the foil-laminated
19 material are separated; straining the stripping agent from the separated layers of
20 the foil-laminated material; neutralizing the stripping agent remaining on the
21 separated layers; cleaning the separated layers; drying the separated layers; and
22 classifying the separating layers for a subsequent recycling process.

23 The foil-laminated material is composed of a foil layer laminated with at
24 least one permeable-layer such as a plastic layer or a paper layer by forming

1 alumina at interfaces. In this method, the stripping agent containing at least nitric
2 acid is used to permeate the plastic layer or the paper layer to dissolve alumina at
3 interfaces to divide the foil-laminated material into a separated foil layer and a
4 separated plastic layer or a separated paper layer. Selectively, the foil-laminated
5 material can be a foil packaging, a cable covering, a plastic tube with foil
6 laminations and so on. Detail descriptions and operational conditions in this
7 method are illustrated as following:

8 With reference to Figs. 1 and 2, the separating method for recycling
9 foil-laminated material comprises the following operational acts in practice.

10 The foil-laminated material waste is collected in a basket (not shown)
11 hooked under a hoisting machine (1) and lowered to soak in a stripping tank (2)
12 containing a stripping agent. The stripping agent is an acid solution containing
13 nitric acid and has 15~68% concentration of nitric acid. The stripping agent
14 selectively adds acetic acid and phosphoric acid to make the stripping agent have
15 more stripping efficiency. Optionally, a heating process is carried out within a
16 temperature range of 40~70°C when soaking the foil-laminated material to
17 accelerate stripping speed. An inducing pipe (3) is mounted on a top of the
18 stripping tank (2) to collect toxic gases generated during the stripping process
19 and to transport to an exhaust gas treating equipment to process those gases until
20 they are transformed for safe emission.

21 After separating different layers of the foil-laminated material, the
22 hoisting machine (1) brings the basket with the separated layers of foil layers,
23 plastic layers, and paper layers to a solution-collecting tank (4). In the solution-
24 collecting tank (4), the stripping agent remaining on surfaces of each separated

1 layer is drained out into the solution-collecting tanks (4) to keep the separated
2 layers damp but not wet.

3 Then, the basket with the solution-strained separated layers of foil layers,
4 plastic layers, and paper layers of the foil-laminated material moves to a washing
5 tank (5). In the washing tank (5), a high-pressure washer (6) is attached inside the
6 washing tank (5) to wash off with water most of the stripping agent remaining on
7 surfaces of the separated layers.

8 After washing, the washed separated layers of foil, plastic and paper of
9 the foil-laminated material move to an ultrasonic neutralizing tank (7)
10 accommodating basic solution containing sodium hydroxide. The basic solution
11 of sodium hydroxide neutralizes the stripping agent of nitric acid to avoid
12 causing injury to operators who handle separated layers in subsequent operations.
13 Additionally, the ultrasonic vibration in the ultrasonic neutralizing tank (7)
14 cleans impurities from the surfaces of the separated layers to make the recycling
15 of the foil-laminated material further convenient.

16 Then, the cleaned and separated layers of different materials of the foil-
17 laminated material are moved to an unloading stage (8) to be air-dried and
18 classified according to different materials for recycling. Each recycled material
19 is kept separate and is a useful material since each recycled material has high
20 purity.

21 In the separating method for recycling foil-laminated material, the nitric
22 acid in the stripping agent permeates the plastic layer (made mostly of
23 polyethylene) and into the interfaces between the foil layer and the plastic layer
24 to dissolve the alumina (Al_2O_3) and to separate the layers. With regard to the

1 interfaces between the foil layer and the paper layer, the nitric acid also
2 permeates the paper layer to dissolve the alumina to separate the foil layer and
3 the paper layer.

4 Operational conditions of the present invention are that the
5 concentration of the stripping agent is 15~68% and the heating temperature is
6 40~70°C. The concentration of the stripping agent and the heating temperature
7 are determined according to thickness of the plastic layer. Practically, when the
8 concentration of the stripping agent is 68% and the heating temperature is 60°C,
9 a soaking time in the stripping agent for the foil-laminated material is 40-minute.
10 When the concentration of the stripping agent is 34% and the heating
11 temperature is 65°C, the soaking time for the foil-laminated material in the
12 stripping agent is 60-minute.

13 If the stripping act is carried out without heating, the operational
14 conditions are: when the stripping agent is 30~34%, the soaking time is 7-hour;
15 when the stripping agent is 20~30%, the soaking time is 15-hour. Thereby, the
16 heating act accelerates the stripping of the layers of the foil-laminated material to
17 shorten the soaking time.

18 The separating method for recycling foil-laminated material in the
19 present invention has the advantages that the nitric acid permeates the permeable
20 layers to reach interfaces of the foil layer and to dissolve the alumina. Whereby,
21 the layers of the foil-laminated material are completely separated to achieve the
22 purpose of recycling high purity materials. Meanwhile, the method in the present
23 invention uses heating to accelerate the stripping reaction and to shorten the
24 soaking time. Therefore, this method is suitable for treating foil-laminated

1 material in a large quantity batches and has no need to consume electricity or
2 other energy in step of separating layers of the foil-laminated material to have
3 low operation cost.

4 Even though numerous characteristics and advantages of the present
5 invention have been set forth in the foregoing description, together with details
6 of the function of the invention, the disclosure is illustrative only, and changes
7 may be made in detail, especially in matters of shape, size, and arrangement of
8 parts within the principles of the invention to the full extent indicated by the
9 broad general meaning of the terms in which the appended claims are expressed.